(No Model.) 2 Sheets—Sheet 1.

J. W. BOOKWALTER.

APPARATUS FOR CONVERTING CRUDE METAL INTO MALLEABLE IRON OR STEEL.

No. 405,766. Patented June 25, 1889.

Fig. 1.

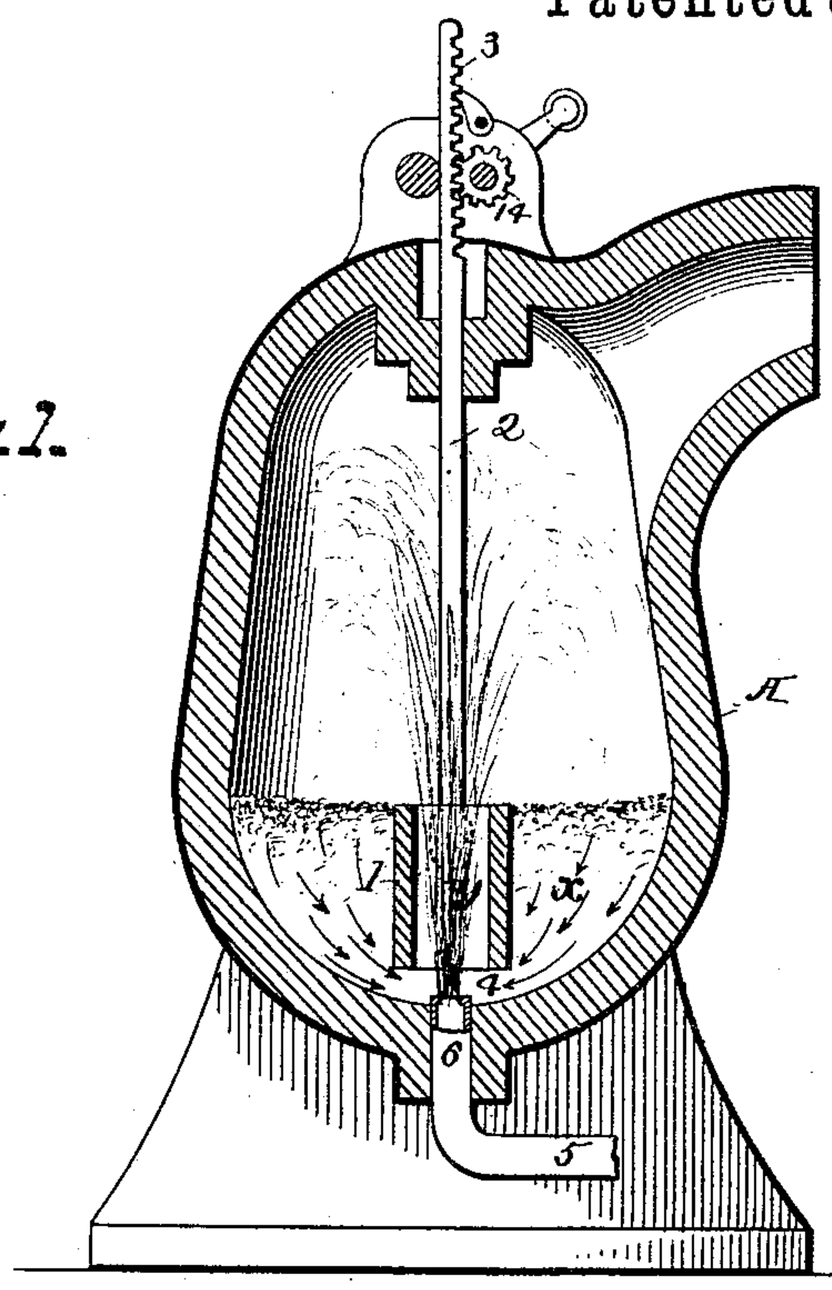


Fig. 2.

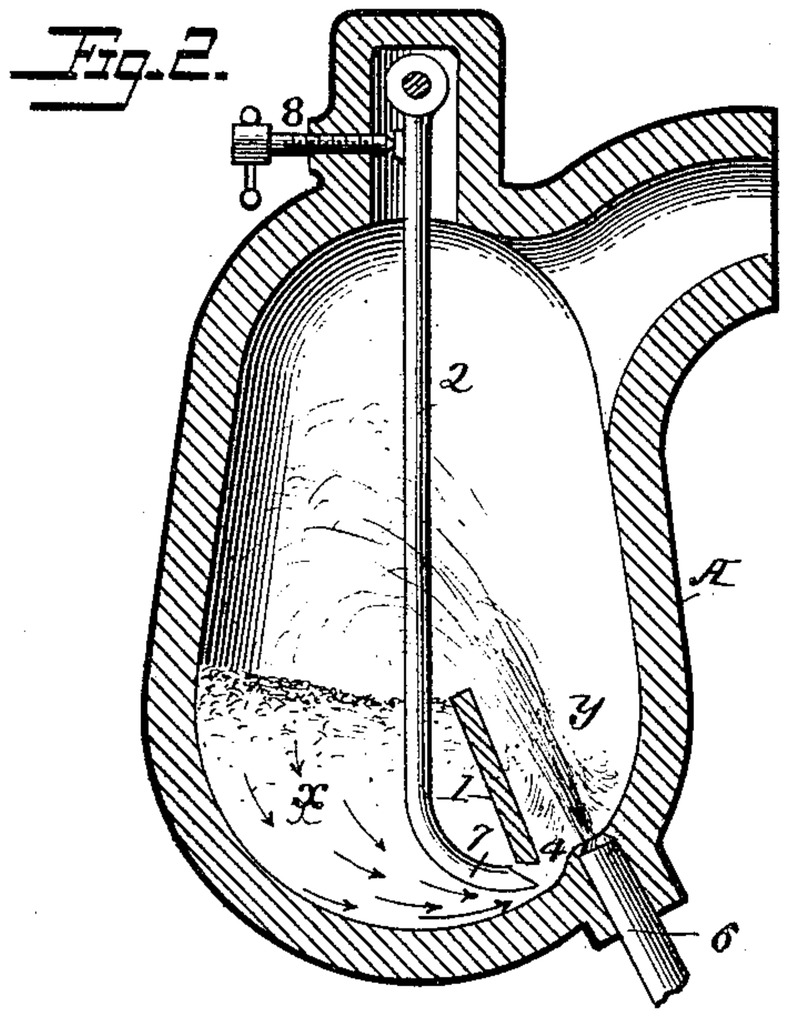
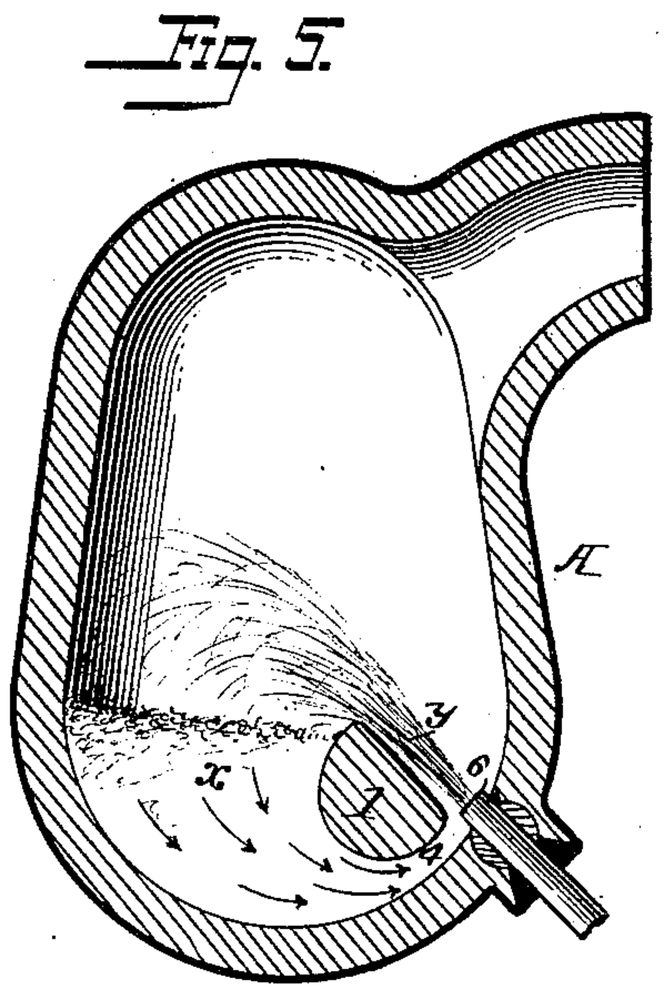


Fig. 5.



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(No Model.) 2 Sheets—Sheet 2.

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Fig. 3.

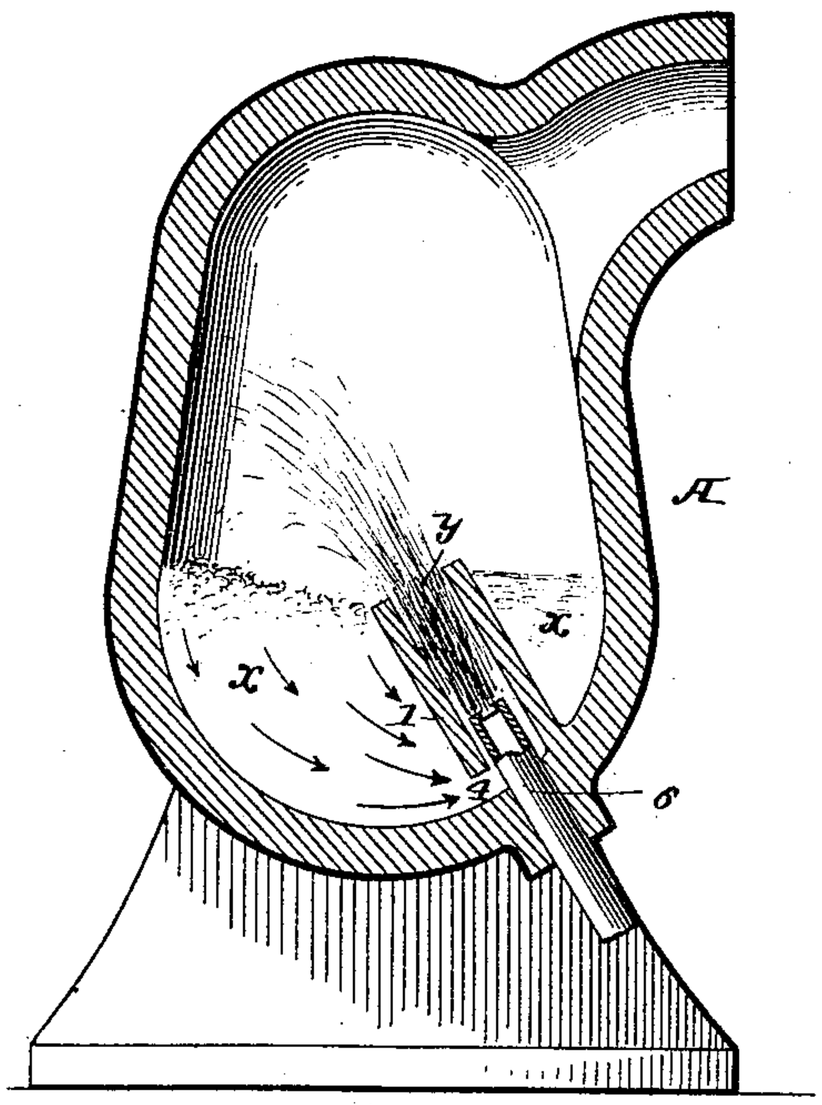
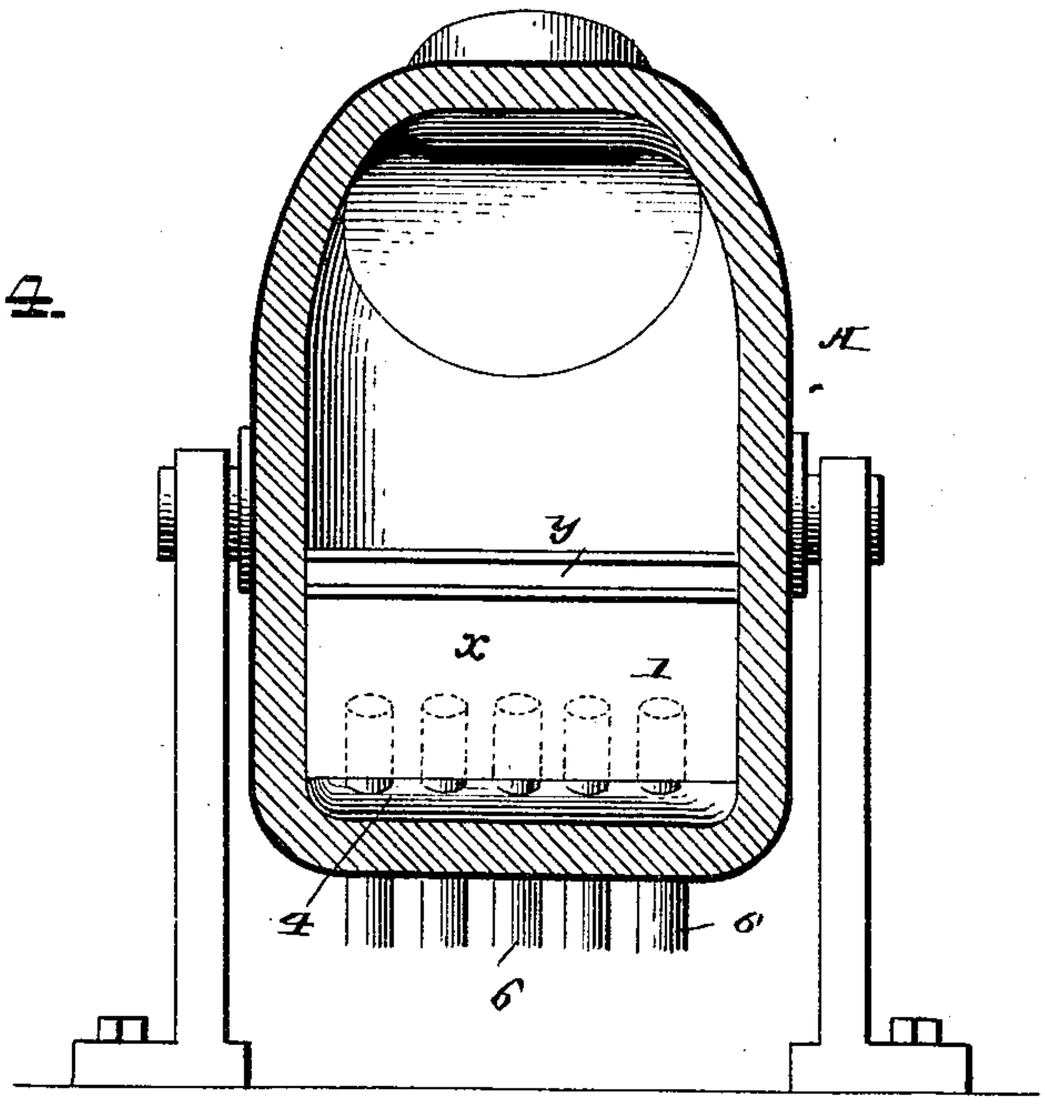


Fig. 4.



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR CONVERTING CRUDE METAL INTO MALLEABLE IRON OR STEEL.

SPECIFICATION forming part of Letters Patent No. 405,766, dated June 25, 1889.

Application filed October 18, 1888. Serial No. 288,486. (No model.)

To all whom it may concern:

Be it known that I, JOHN WESLEY BOOKWALTER, a citizen of the United States, and a resident of Springfield, Clark county, Ohio, have invented certain new and useful Improvements in Apparatus for Converting Crude Metal into Malleable Iron or Steel, of which the following is a specification.

In the ordinary rapid process of converting crude iron into malleable iron or steel, where the air is forced into the metal under pressure, especially in the form of jets, there is a tendency to produce local currents or vortices in portions of the mass of metal, which thus acquire a rapid movement apart from the other portions of the metal, so that the moving portions are brought more intimately under the action of the blast and subjected thereto for a longer period of time than the other portions which do not acquire so rapid a movement. This action is attended with several injurious results.

First. The portion of metal to which the rapid movement has been imparted is liable to be overblown or overconverted.

Second. The impurities eliminated in the process of conversion tend to remain within the body of the metal within the vortices of the local current, so that their ready escape therefrom is prevented, and they cannot accumulate upon the surface as they should in a state of separation from the metal.

Third. The continuous circulation of the scoria in local bodies or portions of the metal mixes them so intimately therewith as to render their removal difficult.

I have discovered that the difficulties to which I have alluded may be overcome and the best grade of malleable iron or steel may be produced by securing a uniformity of contact of the air with every portion of the metal, and that this is essential in order that the decarbonization of the iron may be uniform throughout the entire mass.

Having ascertained that the tendency to form local currents or vortices is much greater when the air-blasts enter the metal near the surface than when they enter at a greater depth below the surface, I devised means whereby to secure a continuously-uniform action of the air upon limited uniform quantities of the metal at one time, feeding the metal gradually to the air within a fixed or limited space. By this means small portions of the metal as they are fed to the air are driven thereby out of the zone of violent agitation of the air and metal, and thereafter are thrown back toward the greater body of metal while a new portion of the latter is being brought under the influence of the air, that portion of the metal which is submitted to the action of the air being the purest portion of the body—that is, having combined with it less scoria than any other portion—and the greater body of the metal which is not under the direct influence of the air being comparatively stationary and free from currents or vortices.

The means which I have devised for effecting the above-described results consist in dividing the converter, or that portion thereof which holds the molten metal, into two portions or chambers, one of which is much larger than the other and contains the main body of the molten metal, and into the smaller of said chambers, which I term the "converting-chamber," the metal is fed at a limited uniform rate, so as to meet a blast of air or other aeriform agent, by which the inflowing stream of metal is forced outward through the converting-chamber and through the space or chamber above the body of molten metal and onto the surface of the latter, this operation being continuous as the metal flows into the conversion-chamber and meets the continuous blast of air, and the operation being continued until every portion of the metal has been so acted upon as to effect the desired conversion, which will be uniform throughout the mass. In addition to the beneficial results issuing from insuring the contact of every portion of the body of metal uniformly with the converting agent, I also by this means prevent the intermingling of the scoria with the purer portion of the metal, inasmuch as the scoria, owing to its specific gravity, remains upon the surface of the larger body of the metal in separation therefrom, and as the body of metal is free from active currents or movements tending to disturb the scoria the latter remains in its position.

The apparatus may be constructed in different ways so as to constitute the chambers and secure the desired uniform intermingling of the metal and the air-blast, and in the accompanying drawings, which form a part of this specification, I have illustrated different constructions, which I will now proceed to describe.

Figure 1 illustrates in section a converter A, which may be of any desired form, and may be either a stationary converter or supported and swing upon trunnions. The lower portion of the converter, which holds the body of the molten metal, is divided into two chambers *x y*, by means of a tubular partition 1, of refractory material, projecting upward from the bottom of the converter and vertically adjustable by any suitable appliance—as, for instance, by a rod 2, extending through the top of the converter and provided with a rack 3, engaging with an elevating-pinion 14, by means of which the rod and tube can be raised and lowered. The lifting of the tube leaves between it and the bottom of the converter a channel 4, through which the molten metal from the chamber *x* may flow into the chamber *y*, and by elevating or lowering the tube 1 the dimensions of the channels may be changed to regulate the flow of the metal into the conversion-chamber *y*. Communicating with the conversion-chamber *y* is an air-pipe 5, terminating in a tuyere or tuyeres or nozzle 6, through which the blast or jets of air may be directed longitudinally through the tube, to meet and carry with it the inflowing current of metal. This air-pipe may project into the chamber *y* to any desired height that may be found best. When the blast constitutes the converting agent, it acts directly upon the small body that flows into the conversion-chamber; but when the blast is not the converting agent it serves to throw the metal as fed into the conversion-chamber into the converting agent, which in such case is introduced into the converter in any suitable manner and in any suitable form—as, for instance, in the form of a gas in the converter above the molten metal. The small body of metal acted on by the blast may be thrown from the conversion-chamber either in a small stream or divided into a spray, according to the speed of the feed. The feed may be regulated by tilting the converter to a greater or less extent as well as by varying the size of the feed-channel, or the strength volume or force of the blast may be varied and effect a like result.

A different form of device for controlling the flow through the channel or channels 4 is shown in Fig. 2, in which a valve 7, carried by a rod 2, is moved to obstruct the channel to a greater or less extent. Thus the rod 2 is pivoted at the upper end and is moved by a screw 8, so as to carry the valve 7 into or away from the channel 4. By rendering adjustable the tube or partition 1, which separates the chambers *x* and *y*, the dimensions of the orifices 4 may be regulated, as described, so as to regulate the flow of the metal and properly proportion the same to the quantity of air which is admitted to the conversion-chamber, and by arranging the orifices or channels 4 at the bottom of the chamber *x* the purest portion of the body of the metal is subjected to the action of the air, which would not be the result if the metal were admitted into the conversion-chamber from a point nearer the surface. The quantity of metal admitted into the conversion-chamber may be varied also by varying the pressure of the blast, for by increasing the pressure there is a greater tendency to form a vacuum, and therefore a larger quantity of metal is drawn into the chamber.

In Figs. 3 and 4 the converter is shown as divided into two chambers by means of a partition 1, so that the contents of the conversion-chamber are thrown diagonally across the converter. This partition may consist of two, three, or more of such tubes arranged side by side; or there may be only one continuous diaphragm extending across the converter, thus dividing the same into two chambers, as shown, there being in this case a series of tuyeres or nozzles.

Fig. 5 shows another construction in which the converter is divided into two chambers by a transverse partition 1, which preferably projects above the surface of the metal and is inclined at one side, across which the air-blast at any suitable angle is directed to meet the stream of metal flowing through the channel 4, formed by arranging the partition a short distance above the bottom of the converter. By placing the partition 1 at one side of the converter the conversion-chamber *y* is rendered smaller than the other chamber, so that the metal which flows therein will never exceed in amount the proportion the air-blast can force out of the compartment onto the surface of the metal in the larger chamber.

By a proper enlargement of the thickness of the partition 1, as shown in Fig. 5, it is practicable to impart a substantially curved or rounded form to the face of the partition adjacent to the chamber *x*, so that the downflowing current toward the channel 4 is directed thereto without forming the eddies or vortices liable to result when the current meets a flat surface, and therefore there is secured a more regular and equable flow of metal from the larger bulk into the conversion space or chamber.

In all cases where the tuyere or nozzle is at one side of the converter it may be placed at any desired depth below the top of the conversion-chamber formed by the partition 1, and it may be inclined to any angle or may be adjustable to any angle that will give the best converting effect to the blast and impart the most effective carrying or elevating action to the blast in operating upon the molten metal to carry it from the conversion-

chamber onto the surface of the metal in the larger chamber X.

In any of the forms shown and described the size of the channel 4 may be regulated in any suitable manner, and in the construction shown in Fig. 5 the partition-block 1 can be connected to a pendent bar 2, (shown in dotted lines,) to be swung to and from the bottom of the converter to decrease or increase the size of the channel 4. The nozzle or nozzles may be arranged at any desired height as regards the partition, and to vary the angle as may be required each nozzle may be adjustable. Thus it may extend through a ball-bearing 13, fitting a socket in the converter-wall.

Without limiting myself to the precise construction and arrangement of parts shown, I claim—

1. A converter having at the bottom two chambers, one for holding the body of metal, the other communicating with the first at a point below the normal surface of the metal and constituting a conversion-chamber, and a blast-pipe communicating with the conversion-chamber and arranged to direct the blast upon the inflowing current and upward from the conversion-chamber, substantially as set forth.

2. A converter having its main chamber divided near the bottom by a transverse partition into two chambers of different sizes, said partition having one or more channels connecting the chambers, in combination with a nozzle or tuyere arranged to direct a blast into and from the smaller chamber near the top thereof, substantially as set forth.

3. The combination, with a converter, of a partition dividing the lower portion of the converter into two chambers, a channel connecting the said chambers, means for varying the size of said channel, and a nozzle or tuyere extending into one of the chambers, substantially as set forth.

4. The combination, with a converter, of a partition separating the lower portion of the converter into two chambers, a channel connecting the chambers at a point adjacent to the bottom of the converter, a valve regulating the flow through said channel, and a nozzle or tuyere communicating with one of the chambers, substantially as set forth.

5. The combination, with a converter, of a partition dividing the lower portion of the converter into two chambers of different sizes and having a rounded or curved side adjacent to the larger chamber, a channel connecting the two chambers near the bottom of the converter, and a nozzle or tuyere extending to the smaller chamber, substantially as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN WESLEY BOOKWALTER.

Witnesses:

CHASE STEWART,

O. N. STEWART.